

BOTANICAL MUSEUM LEAFLETS

HARVARD UNIVERSITY

CAMBRIDGE, MASSACHUSETTS, DECEMBER 11, 1950

VOL. 14, No. 7

PREHISTORIC PLANT REMAINS FROM BAT CAVE

BY
C. E. SMITH, JR.

DURING the summer of 1948, an archeological expedition under the direction of Mr. Herbert W. Dick of the Peabody Museum of Harvard University discovered an abundance of plant remains in a series of dry caves in New Mexico. The maize remains in this material have already been reported on (Mangelsdorf and Smith 1949). The balance of the plant material will be discussed in the present paper.

DESCRIPTION OF THE SITE

The site is known as Bat Cave. It is situated on the edge of the Plains of San Augustin in Catron County in west central New Mexico. The topography of the region has largely been determined by ancient Lake San Augustin, which formed the caves. The lake basin is a level expanse of fine water-laid material with occasional spots of alkali in the playa. It is almost entirely surrounded by mountainous terrain and is approximately 60 miles long and 6 to 20 miles wide.

The Bat Cave site consists of a large rock shelter (75 feet by 100 feet) with a series of smaller caves at one side. The smaller caves are 10 to 30 feet deep, and about 10 to 15 feet from the present floor to the roof near their

mouths. All of the prehistoric material described below came from these small caves.

PRESENT VEGETATION

A description of the present vegetation of the area will serve as a basis for comparison with the material to be described from the deposit. Near Bat Cave, the plains consist of a large playa supporting a sparse growth of four-winged salt bush (*Atriplex canescens* (Pursh) Nutt.), with areas of *Heliotropium curassavicum* L. and *Sporobolus airoides* (Torr.) Torr. The transition zone from the plain to the fossil lake terraces is marked by Russian thistle (*Salsola pestifer* A. Nels.). On the terraces *Bouteloua hirsuta* Lag. forms a thicker ground cover than is present on the plains. Numerous plants of the groundsel (*Senecio longilobus* Benth.), stickseed (*Lappula Redowskii* (Hornem.) Greene), stickleaf (*Mentzelia pumila* (Nutt.) Torr. & Gray), paintbrush (*Castilleja minor* A. Gray), mock pennyroyal (*Hedeoma Drummondii* Benth.) and verbena (*Verbena ciliata* Benth.) show that this area is relatively free of alkali. In the rocky areas of the terraces a shrubby vegetation is present. *Fallugia paradoxa* (D. Don) Endl. (Apache plume) is very common, while *Rhus trilobata* Nutt. ex Torr. & Gray, *Forstiera*, *Lycium* and *Ribes* spp. comprise the rest of the shrub flora near Bat Cave.

The arroyos and canyons nearby are better watered (although none have permanent streams) and consequently the herbaceous vegetation is more varied. Numerous members of the *Compositae*, *Boraginaceae*, *Labiatae*, *Leguminosae* and other families were collected. In no case, however, was there any extensive ground cover formed by these plants.

At an elevation of 200 to 400 feet above the level of the plains a distinct change in the vegetation is seen.

Pinus edulis Engelm. and *Juniperus* spp. are dominant, while *Bouteloua hirsuta* Lag., *Bouteloua curtipendula* (Michx.) Torr. and other grasses form an almost continuous ground cover with scattered herbaceous plants and cacti (mainly *Opuntia* spp.). In one canyon near Bat Cave there are several trees of *Pinus ponderosa* Dougl. ex P. Laws. No other occurrence of ponderosa pine was seen near the site.

During the dry season the vegetation has a distinctly xerophytic aspect emphasized by the scattered plants of *Opuntia* and *Mammillaria*. Only the heliotrope on the plains and the shrubs on the terraces remain green. The dark green of the piñon and juniper contrasts with the brown ground cover.

With the advent of the summer rains in July and August, many short-lived herbs appear over the plain and hills making the entire area green. Most of the vegetation blooms during this period. Heavy rains in the hills and mountains usually fill the canyon beds with temporary streams for several hours each day, and standing pools form on the playa.

EXCAVATION

The vegetal material recovered from Bat Cave was collected during the course of excavation for archeological remains. Measured areas were carefully dug by hand troweling in twelve inch levels from the top of the deposit. The material of botanical interest was removed and packaged. These arbitrary strata have no relation to any archeological strata which may exist in the Bat Cave deposit. Many cubic yards of material were removed so that a fair sampling of the entire deposit was obtained. Vegetal artifacts, to be described later by Mr. Dick, were packaged separately. Aside from the maize remains previously studied, no attempt was made in the

field to separate cultivated plants from wild species, although the specimens of beans and squash recovered were obviously cultivated.

DETERMINATION OF THE REMAINS

All of the determinations are based upon characters of taxonomic significance. Fragmentary material has often been given only a generic name due to lack of the detail needed for specific determination. A small amount of the material proved indeterminable.

The identification of the wood and charcoal remains presented certain technical difficulties in handling the material. An unsuccessful attempt was made to soften the charcoal enough to permit sectioning. In most cases there was complete disintegration in the bleach solution. Some few samples did not crumble, but these did not soften sufficiently to be sectioned.

The wood remnants were softened by boiling. Because of partial disintegration and chemical change, it was found that no further softening by hydrofluoric acid treatment was necessary. Although some material was left unstained, the bulk of the wood sections were stained by Heidenhain's haematoxylin and safranin before being permanently mounted.

Except for the wood of the conifers and *Quercus*, the only tree genera represented, the material could only be identified after comparison with a set of slides made of known woods occurring at similar elevations today. Much of the old material represents such families as the *Chenopodiaceae*, *Rosaceae*, *Rutaceae*, *Rhamnaceae*, and *Compositae*.

The author wishes to express his sincere thanks for the aid and advice accorded him by Professor Paul C. Mangelsdorf, Professor Ivan M. Johnston, Professor Elso S. Barghoorn and the many others who have as-

sisted in the identification of the material. Especial thanks are due to Dr. S. F. Blake who identified the *Compositae*. Without this expert help, much of the vegetal material would have proven indeterminable.

CULTIVATED PLANTS

There is no evidence that the Bat Cave people cultivated any of the native vegetation, although species such as *Yucca* may well have been planted near the cave to ensure a regular supply of fiber and amole. Many of the herbaceous plants could have been grown with some success, but the bulk of the material was probably prevalent enough in the neighboring area to be easily collected as the need for it arose.

Cucurbita Pepo *Linnaeus* Sp. Pl. (1753) 1010.

Aside from the maize, the only obviously cultivated plants (that is, plants which are foreign to the region, and which show increased size and other marks of cultivation) are squash and beans. All of the cultivated squash remains are referable to *Cucurbita Pepo* L. The material was found in every level (I to VI) and comprises seeds, rind and stems.

The seeds of *Cucurbita Pepo* are all characterized by the moulding near the edge of the seed. Identification is possible because of the difference in texture between the center and the margin of all of the specimens. In specimens without discoloration, there is no difference in color in these areas. The seeds apparently all represent the same variety of *C. Pepo*, as there is no distinct difference apparent in any of them. Furthermore, there is no apparent size variation, as was shown by the maize, from the bottom to the top of the deposit.

Squash seeds

Level	Number seeds	Aver. width	Aver. length
I	2	9.5 mm.	16.0 mm.
II	3	9.9 mm.	15.6 mm.
III	4	9.0 mm.	15.0 mm.
IV	11	9.0 mm.	15.8 mm.
V	3	8.9 mm.	14.9 mm.
VI	9	9.1 mm.	16.4 mm.
TOTAL AVER.	32	9.2 mm.	15.6 mm.

The average seed length is 15.6 mm., the largest strata average being 16.4 mm. for stratum VI. The average seed width is 9.2 mm., the largest strata average being 9.9 for stratum II.

Many pieces of rind were recovered from the excavation, none of which were sufficiently large to permit an accurate reconstruction of the size of the fruit. These remains show no significant differences in thickness or appearance. The surface texture is generally smooth, a few pieces showing slightly raised areas. There is prominent veining on the inside of all of the specimens. The thickness varies from about 1.5 mm. to about 3.5 mm., the average thickness being about 2.5 mm. Several pieces of rind showing the flower attachment were found. These were always concave in form, indicating that the fruit was probably the shape of our modern pumpkin.

Three stems were found in the course of the excavation. These are typical *Cucurbita Pepo* stems, flaring at the point of attachment with the fruit, pentagonal in shape and regularly fluted. Some idea of the size of the fruits may be gained from the size of the stems.

Squash stems

Level	Number stems	Length	Diameter (upper end)	Diameter (lower end)
II	1	4.3 cm.	1.8 cm.	3.0 cm.
IV	1	7.5 cm.	2.0 cm.	3.3 cm.
V	1	6.0 cm.	1.8 cm.	2.8 cm.

The oldest stem was found in stratum II and was apparently cut from the fruit while still green. The length of this specimen is 4.3 cm., with a diameter at the upper end of about 1.8 cm., and a diameter at the lower end about 3 cm. A whole stem, recovered from stratum IV, is 7.5 cm. long, 2 cm. in diameter at the upper end and 3.3 cm. in diameter at the lower end. The third specimen from stratum V is about 6 cm. long with a diameter of approximately 1.8 cm. at the upper end, and 2.8 cm. at the lower end.

Phaseolus vulgaris *Linnaeus* Sp. Pl. (1753) 723.

Only a few specimens of the common red bean were recovered. These have a smooth red coat with a white hilum or eye. There is no marked difference in size or appearance from level to level.

Common beans

Level	Number beans	Average width	Average length
III	2	8.5 mm.	13.0 mm.
IV	4	7.1 mm.	11.1 mm.
VI	1	8.0 mm.	11.0 mm.

The largest beans and the earliest in age were the two specimens from stratum III (average width 8.5 mm. and average length 13 mm.). In stratum IV the beans averaged 7.1 mm. in width and 11.1 mm. in length. From stratum VI a single bean 8 mm. wide and 11 mm. long was recovered. A buckskin bag of beans was found in stratum V, but these beans were not available for study. The apparent decrease in size upward in the deposit is probably due largely to the lack of sufficient material for comparison. There is no ready explanation for the lack of beans in strata I and II where both maize and squash are well represented.

Contrary to the evolutionary series presented by the Bat Cave maize, neither the cucurbits nor the beans show

any marked developmental trend. The material available for study does not furnish the detail found in the maize remains, and there is little variation discernible in the squash seeds and beans. The number of squash stems is also insufficient to furnish much information. Furthermore, the squash rind is devoid of any characteristic detail. From the material studied it may be concluded that at the time maize was first cultivated in a primitive form at Bat Cave, *C. Pepo* was cultivated for its rather large fruit. This squash apparently changed little if at all, while the maize underwent a distinct development. *Phaseolus vulgaris* does not appear in the oldest third of the Bat Cave deposit. There is no apparent change in character in the beans. It may perhaps be significant that the first beans appear in stratum III in which the first teosinte introgression is discernible in the maize.

Helianthus annuus *Linnaeus* Sp. Pl. (1753) 904.

Throughout the entire deposit flowering heads of *Helianthus annuus* L. occur. There is no indication that sunflowers were actually cultivated for their seed, although they may well have been, as in other parts of the southwest. The heads are of a size similar to those of the wild plants which are very common in better watered parts of the region today. These heads are about 2.5 to 3.5 cm. in diameter, and they vary in no way from the bottom to the top of the deposit.

UNCULTIVATED PLANTS

The remainder of the Bat Cave vegetal remains may be assumed to be uncultivated, as they are mainly materials which could easily have been gathered in a wild state in the vicinity of the Cave. Descriptions are listed in taxonomic sequence according to the Engler and Prantl system, rather than according to abundance or

supposed importance in the deposit. It is felt that this will be a more usable plan for reference.

PINACEAE

***Pinus edulis* Engelmann** in Wislizenus Mem. North. Mex. (1848) 88.

Piñon nuts were one of the most abundant plant remains found in the Bat Cave deposit. Many hundreds of broken shells were unearthed with a few whole nuts, several cones and an occasional twig.

In strata I and II this species is represented by nuts and cone scales. The remains in stratum III include a twig with needles attached, as well as cones, cone scales and seeds. From stratum IV piñon is represented by both seeds and cone scales. In both strata V and VI abundant seeds, cones, cone scales and twigs were recovered.

Thus, *P. edulis* is represented during the entire period of occupation of Bat Cave.

***Pinus ponderosa* Douglas ex P. Lawson**, Agr. Man. (1836) 354.

Remains of this tree were found only in strata V and VI. In stratum V ponderosa pine is represented by the ends of two twigs with the needles adherent. A number of separate needles and a cone were recovered from stratum VI.

***Pinus* sp.**

Wood of a species of *Pinus* was found in all strata except I.

***Juniperus pachyphloea* Torrey** in U.S. Rept. Expl. Miss. Pacif. 4 (1857) 142.

Remains of juniper first occur in stratum II where the

plant is represented by large seeds. These may not be seeds of *J. pachyphloea*, although the resemblance is close. There were no remains identifiable as juniper in stratum III. The seeds and berry found in stratum IV are characteristic of *J. pachyphloea*, as are the numerous seeds, berries and twigs bearing leaves found in both strata V and VI.

Juniperus sp.

This genus is represented by wood fragments from all but the first two strata.

The large amount of juniper remains in the upper three strata contrasts sharply with the few seeds from stratum II and the lack of material from strata I and III. Using piñon remains as a criterion, there must have been juniper trees in the area for the entire time of occupation, so their absence in the lower parts of the deposit should be attributed to disuse rather than to lack of available material.

TYPHACEAE

Typha latifolia *Linnaeus* Sp. Pl. (1753) 971.

Remains of aquatic or marsh plants are relatively rare in the Bat Cave deposit. A portion of cattail leaf was found in stratum IV. The largest amount of cattail material, however, came from stratum V where numerous pistillate heads and a small staminate head of *T. latifolia* were recovered.

At the present time, cattails grow only in recently made ponds at Jacks Spring and T.U.T. Spring twelve miles across the plain from Bat Cave. The abundance of the cattail remains therefore suggests that during the period represented by strata IV and V there was a permanent body of shallow water nearby. Probably the large playa in front of the cave was at that time supplied

with sufficient summer rain and winter snowfall to support a shallow water vegetation.

GRAMINEAE

Festuca Kingii (*S. Wats.*) *Cassidy* in Colo. Agr. Expt. Sta. Bull. 12 (1890) 36.

Fruiting heads of this grass were found in stratum VI.

Poa Fendleriana (*Steud.*) *Vasey* in U.S. Dept. Agr., Div. Bot. Bull. 13, pt. 2 (1893) pl. 74.

This grass was found in levels IV, V and VI of the Bat Cave deposit.

Poa secunda *Presl* Rel. Haenk. 1 (1830) 271.

A sample of *P. secunda* was among the grasses recovered from strata III and IV.

Elymus salina *M. E. Jones* in Proc. Calif. Acad. Sci. ser. 2, 5 (1895) 725.

Fruiting material was found in stratum VI.

Sitanion Hystrix (*Nutt.*) *J. G. Smith* in U.S. Dept. Agr., Div. Agrost. Bull. 18 (1899) 15.

This grass was also found represented only in stratum VI.

Trisetum Wolfii *Vasey* in U.S. Dept. Agr. Monthly Rept. Feb., March (1874) 156.

Several specimens of *T. Wolfii* were found in strata IV, V and VI.

Calamagrostis inexpansa *A. Gray* Gram. and Cyp. 1 (1834) no. 20.

C. inexpansa was found only in strata V and VI.

EXPLANATION OF THE ILLUSTRATION

PLATE XLI. (Upper fig.). Plains of San Augustin, New Mexico. Numerous clumps of saltbush (*Atriplex canescens*) thinly interspersed with grasses and a few herbaceous plants. In the middle foreground is the large playa in front of Bat Cave. Elevation about 6500 feet.

(Lower fig.). Juniper (left) and piñon on the hills directly above Bat Cave at an elevation of about 7000 feet. Ground cover here is heavier with grasses, herbaceous plants, and cacti.

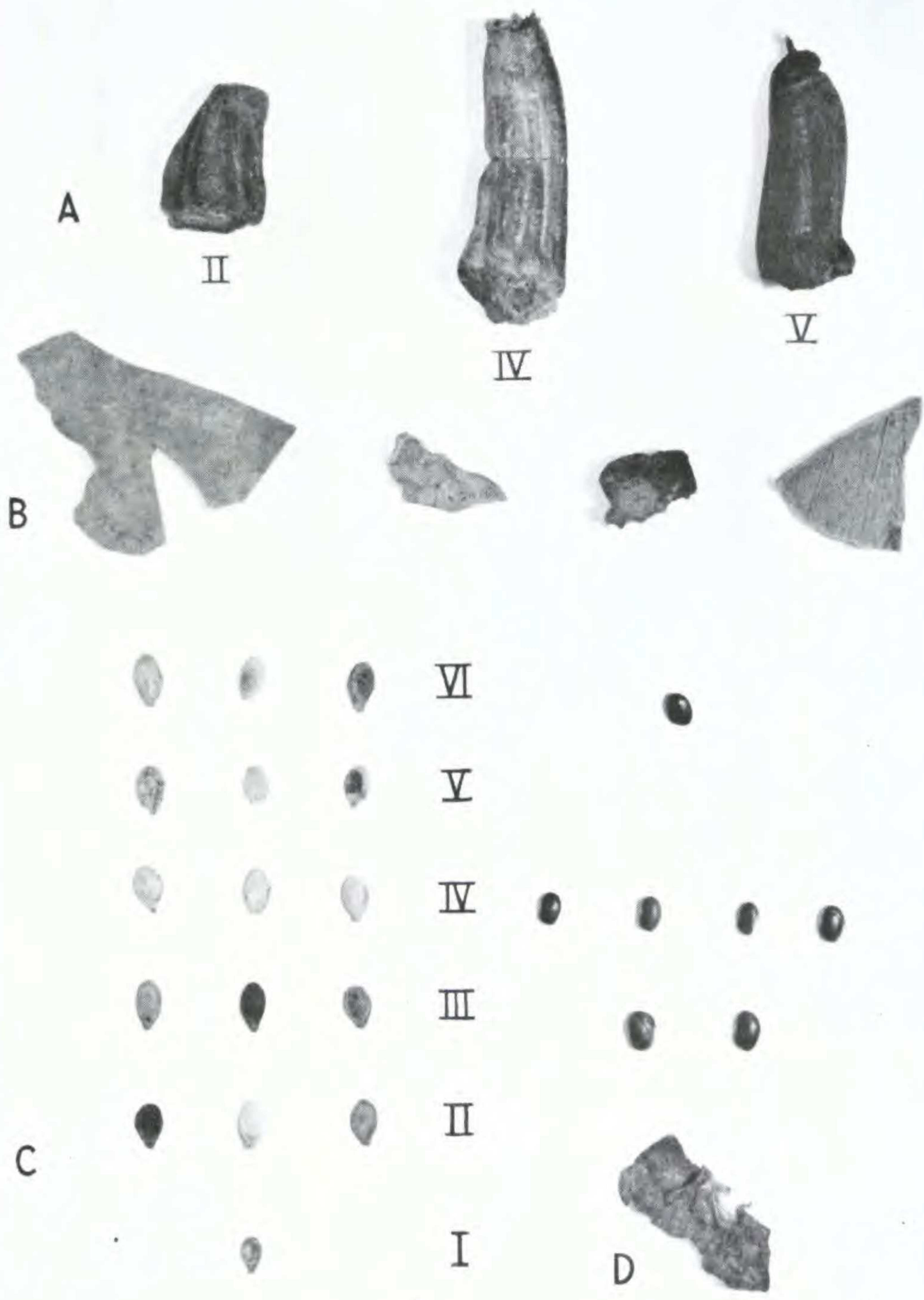
PLATE XLI



EXPLANATION OF THE ILLUSTRATION

PLATE XLII. Remains of cultivated squash (*Cucurbita Pepo*) and beans (*Phaseolus vulgaris*) from the deposit. A, stems from strata II, IV and V. B, specimens of rind from various strata. Note the concave basal portions. C, squash seeds and beans from strata as marked. D, fragment of rind of the native wild cucurbit (*Cucurbita foetidissima*) with attached seeds.

PLATE XLII



EXPLANATION OF THE ILLUSTRATION

PLATE XLIII. Gymnospermae and Monocotyledoneae from the Bat Cave deposit. A, *Pinus*. B, *Juniperus*. C, *Typha latifolia*. D, *Scirpus*. E, *Gramineae*. F, *Yucca*.

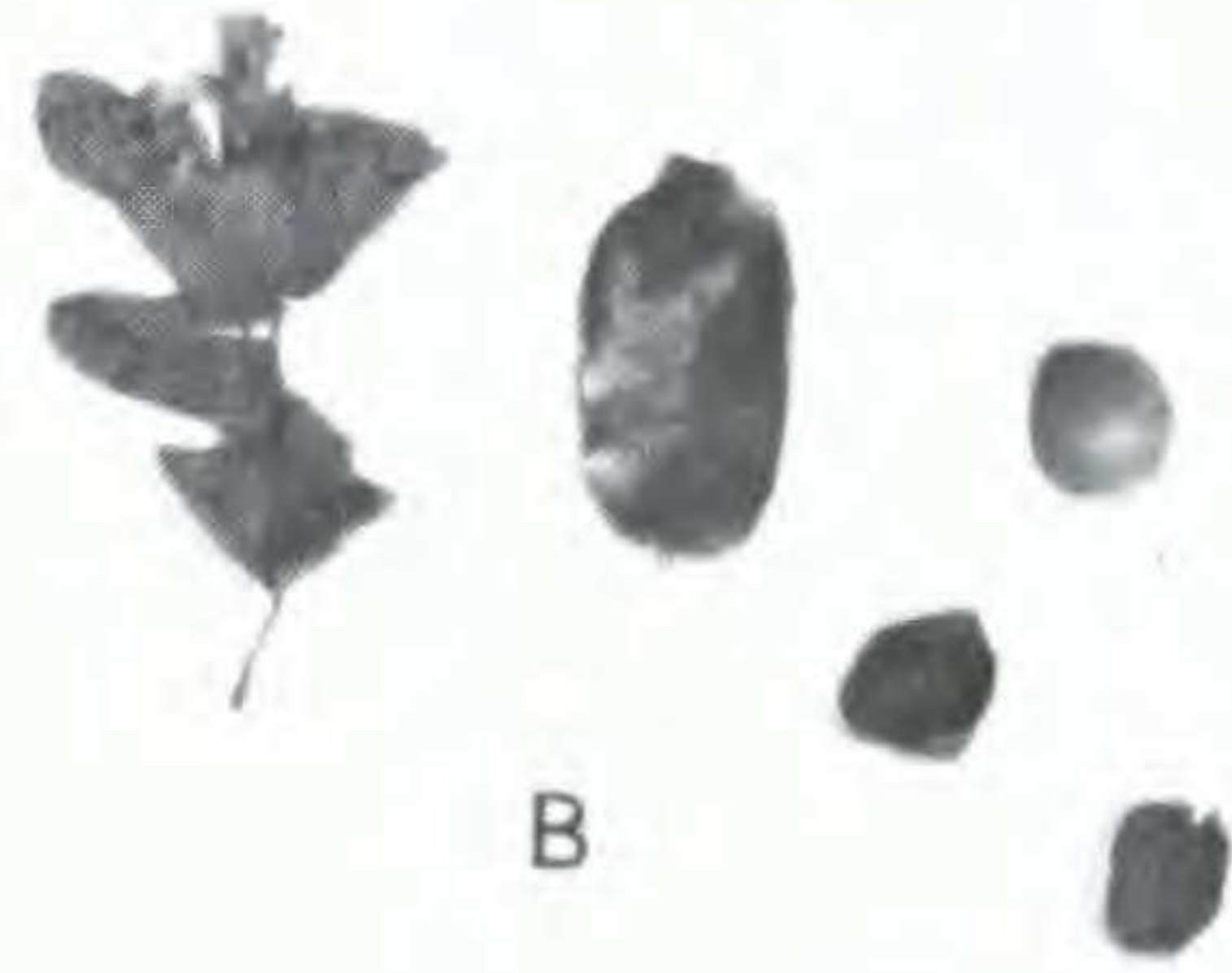
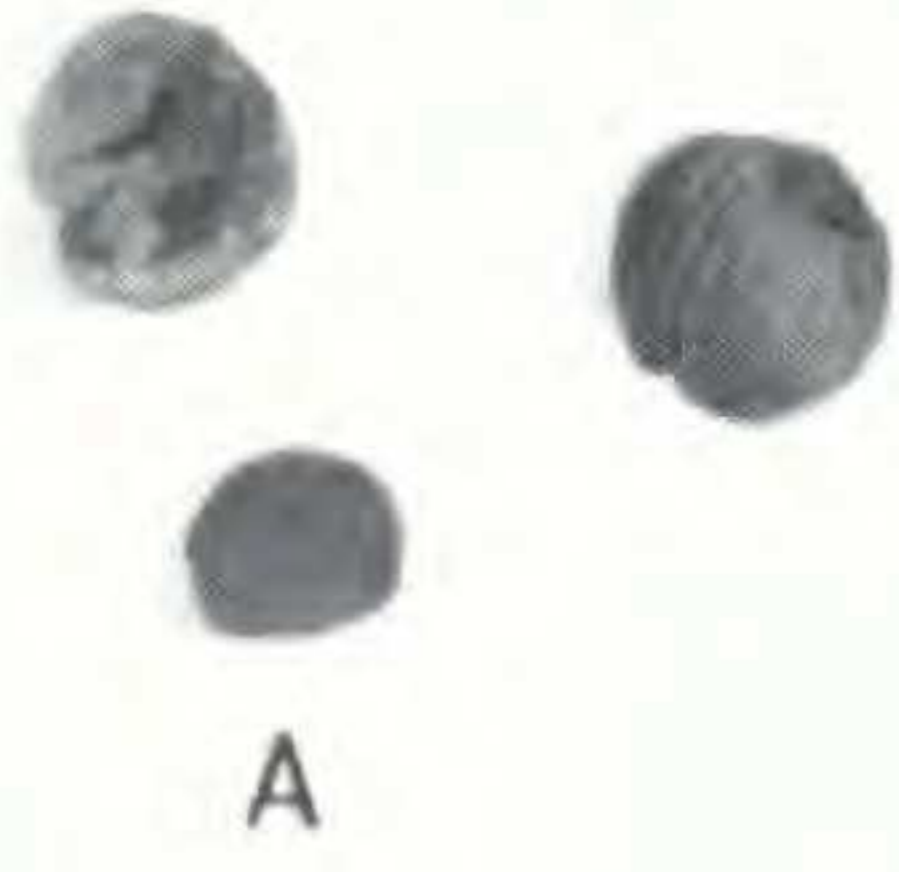
PLATE XLIII



EXPLANATION OF THE ILLUSTRATION

PLATE XLIV. Dicotyledoneae from the Bat Cave deposit. A, *Juglans major*. B, *Quercus*. C, *Amaranthus*. D, *Suaeda*. E, *Opuntia*. F, *Helianthus annuus*.

PLATE XLIV



Muhlenbergia rigens (*Benth.*) *Hitchcock* in Journ. Wash. Acad. Sci. 23 (1933) 453.

In strata IV and VI specimens of this grass were found.

Sporobolus airoides (*Torr.*) *Torrey* in U.S. Rept. Expl. Miss. Pacif. 7 (1856) 21.

Abundant remains of this grass were found throughout the deposit from stratum II upward.

Sporobolus Wrightii *Munro ex Scribner* in Bull. Torrey Bot. Club 9 (1882) 103.

Specimens of stems were found from stratum III upward. Fruiting heads of *S. Wrightii* were found only in stratum VI.

Bouteloua gracilis (*HBK.*) *Lagasca ex Steudel* in Nom. Bot. ed. 2, 1 (1840) 219.

The remains identified as *B. gracilis* were found in strata II and III.

Bouteloua hirsuta *Lagasca* Var. *Cienc.* 2, pt. 4 (1805) 141.

This is one of the most common grass remains from Bat Cave occurring from stratum II upward.

Sorghastrum nutans (*L.*) *Nash* in Small, Fl. Southeast. U.S. (1903) 66.

One specimen of this grass was recovered from stratum V.

Although much material representing the *Gramineae* was found, there is little which may be inferred from the material at hand. The prevalence of *Sporobolus airoides* and *Bouteloua hirsuta* throughout the deposit from stratum II upwards emphasizes the continuity in vegetation

in the area for the last several thousand years. No typically aquatic grasses were found. None of the grasses represented seem to have been gathered for food, so that a continuous maize economy probably furnished the entire grain supply for the Bat Cave people.

CYPERACEAE

Scirpus Olneyi *A. Gray* in *Boston Journ. Nat. Hist.* 5 (1845) 238.

A complete inflorescence as well as several detached heads of *S. Olneyi* were found in stratum V.

Scirpus validus *Vahl* *Enum. Pl.* 2 (1806) 268.

A fruiting head of this bulrush was also found in stratum V.

Scirpus sp.

Fragments of the thick leaves of an aquatic plant apparently a *Scirpus*, were recovered from stratum IV of Bat Cave.

The presence of these typically aquatic plants, as well as *Typha latifolia*, in strata IV and V would seem to be conclusive evidence for the presence of a permanent, although perhaps shallow, body of water in the area of Bat Cave during the period of occupation.

LILIACEAE

Yucca baccata *Torrey* in *Emory Rept. U.S. & Mex. Bound. Surv. (Bot.)* (1859) 221.

Identifiable remains of this species were found in strata II and III.

Yucca spp.

Numerous portions of yucca leaves, seed pods and seeds were found throughout the deposit. In addition,

two sections of rhizome, one from stratum IV and the other from stratum VI, were recovered. Minor differences show that at least two species are present, but lack of definitive characters makes impossible the accurate identification of these remains.

SALICACEAE

Populus tremuloides *Michaux* Fl. Bor. Amer. 2 (1803) 243.

Poplar leaves were recovered from stratum V. The occurrence of this species with *Typha* and *Scirpus* further emphasizes the probable occurrence of higher precipitation in the area of Bat Cave in former times.

JUGLANDACEAE

Juglans major (*Torr.*) *Heller* in *Muhlenbergia* 1 (1900) 50.

Numerous fragments of walnut shells occur throughout the Bat Cave deposits.

FAGACEAE

Quercus Gambellii *Nuttall* in *Journ. Acad. Nat. Sci. Phila.* ser. 2, 1 (1848) 179.

Leaf remains of *Q. Gambellii* were found in strata V and VI.

Quercus grisea *Liebmann* in *Overs. Danske Vidensk. Selsk. Forh.* 1854 (1854) 171.

This species is represented in the deposit by leaves from stratum II upward.

Quercus sp.

Acorns were found in abundance in stratum III. A single acorn shell was recovered from stratum V.

Wood of *Quercus sp.* was found to be most prevalent in stratum III where six specimens were recovered. This genus is represented by only one other wood specimen from stratum VI.

It is not surprising to find *Quercus* remains in the Bat Cave deposit, as oaks grow in the area today in the better watered canyons. This further points to the great similarity of the past vegetation of the area to that of the present. It is unusual, though, that there should be so many acorn shells and no juniper remains in stratum III. At the time represented by this stratum there must have been a much greater abundance of oak in the area, which in turn would suggest a slightly higher rainfall than that of today.

CHENOPODIACEAE

Chenopodium sp.

Remains belonging to this genus were found in stratum IV.

***Atriplex canescens* (Pursh) Nuttall** Gen. No. Amer. Pl. 1 (1818) 197.

Typical four-winged fruits of this plant were recovered from strata IV and VI.

The shrubby members of the *Chenopodiaceae* are represented by the wood of *Atriplex* (*canescens?*) and other woody material identifiable only to family. The former is a very common shrub of the area today. The *Atriplex* wood was found in stratum I, while the other material came from strata II, III, IV and VI.

***Suaeda suffrutescens* S. Watson** in Proc. Amer. Acad. 9 (1874) 88.

In strata I and V were found twigs of this plant.

AMARANTHACEAE

Amaranthus blitoides *S. Watson* in Proc. Amer. Acad. 12 (1877) 273.

One specimen was found in stratum V.

Amaranthus hybridus *Linnaeus* Sp. Pl. (1753) 990.

This species was found only in stratum I.

Amaranthus Powellii *S. Watson* in Proc. Amer. Acad. 10 (1875) 347.

This is one of the most common plants in the deposit and is represented by material from strata II, III, V and VI.

Amaranthus sp.

A specimen of *Amaranthus* from stratum IV was too fragmentary for specific identification.

Plant remains representative of the centrosperms were found repeatedly in the Bat Cave excavation, probably because of their usefulness as food in an area where there is no surplus of wild food plants. Here again similarity to the present vegetation in the area of Bat Cave is apparent.

SAXIFRAGACEAE

Ribes spp.

Ribes (aureum?) wood came from strata I, II and IV, while two specimens of *Ribes*, unidentified as to species, were recovered from strata I and VI.

ROSACEAE

The family *Rosaceae* is represented by a single specimen of wood from stratum I.